

SECTION 23 64 00
PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Microprocessor controlled water-cooled chillers utilizing screw compressors, complete with accessories.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 21 23, HYDRONIC PUMPS.
- E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Section 23 21 13, HYDRONIC PIPING.
- G. Section 23 31 00, HVAC DUCTS AND CASINGS
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 DEFINITION

- A. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- B. BACNET: Building Automation Control Network Protocol, ASHRAE Standard 135.
- C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- D. FTT-10: Echelon Transmitter-Free Topology Transceiver.
- E. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- F. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- G. LonWorks: Network technology developed by the Echelon Corporation.

1.4 QUALITY ASSURANCE

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, and comply with the following.
- B. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.

- C. Comply with ARI requirements for testing and certification of the chillers.
- D. Refer to WARRANTY as noted below:
1. A 5-year motor/transmission/compressor warranty shall be provided based upon the RPM of the compressor as follows:

Compressor RPM	Warranty Term
0-5000	1 year from start up
5001-10,000	5 years from start up
10,001 and above	5 years plus annual oil analysis
 2. Warranty shall include parts and labor for one year after start-up or 18 months from shipment, whichever occurs first.
- E. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard.
- F. Equipment and installation shall be in compliance with ANSI/ASHRAE 15 (latest edition).
- G. Refer to ASHRAE Standard 15, Safety Standard for Refrigeration System, for refrigerant vapor detectors and monitor.
- H. Chiller shall be designed and constructed to meet UL requirements and have labels appropriately affixed.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Refrigeration Institute (ARI):
- 210/ 240-03.....Unitary Air Conditioning and Air-Source Heat Pump Equipment
 - 370-01.....Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
 - 495-99.....Refrigerant Liquid Receivers
 - 550/590-03.....Standard for Water Chilling Packages Using the Vapor Compression Cycle
 - 560-00.....Absorption Water Chilling and Water Heating Packages
 - 575-94.....Methods for Measuring Machinery Sound within Equipment Space
- C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
- 15-02.....Safety Standard for Mechanical Refrigeration Systems

- 3-96.....Guidelines for Reducing Emission of Halogenated
Refrigerants in Refrigeration and Air-
Conditioning Equipment and Systems
- D. American Society of Mechanical Engineers (ASME):
1998ASME Boiler and Pressure Vessel Code, Section
VIII, "Rules for Constructive Pressure Vessels"
- E. American Society of Testing Materials (ASTM):
C 534-03.....Preformed, Flexible Elastomeric Cellular Thermal
Insulation in Sheet and Tubular Form
C 612-04.....Mineral-fiber Block and Board Thermal Insulation
- F. National Electrical Manufacturing Association (NEMA):
250-03.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- G. National Fire Protection Association (NFPA):
70-05.....National Electrical Code
- H. Underwriters Laboratories, Inc. (UL):
1995-99..... Heating and Cooling Equipment

1.6 SUBMITTALS

- A. Submit in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data.
1. Screw water chillers, including motor starters, control panels, and vibration isolators, and remote fluid cooler data shall include the following:
 - a. Rated capacity.
 - b. Pressure drop.
 - c. Efficiency at full load and part load without applying any tolerance indicated in the ARI 550/590/Standard.
 - d. Refrigerant.
 - e. Accessories.
 - f. Installation instructions.
 - g. Start up procedures.
 - h. Wiring diagrams, including factor-installed and field-installed wiring.
 - i. Noise data report. Manufacturer shall provide noise ratings. Noise warning labels shall be posted on equipment.
- C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- D. Run test report for all chillers.

- E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with ARI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.

PART 2 - PRODUCTS

2.1 CHILLERS

- A. General: Factory assembled, single piece, water-cooled liquid chiller shall consist of compressor, motor, starter, lubrication system, cooler, condenser, initial oil and refrigerant operating charges, microprocessor control system, and documentation required prior to start-up. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge and special features required prior to start-up.
- B. Compressor:
1. Semi-hermetic twin-screw compressors with internal muffler and check valve.
 2. Each compressor shall be equipped with a discharge shutoff valve.
 3. Connections to the compressor shall be flanged or bolted for easy disassembly.
- C. Evaporator:
1. Shall be tested and stamped in accordance with ASME Code (U.S.A.) for a refrigerant working-side pressure of 220 psig (1408 kPa).
 2. Shall be mechanically cleanable shell-and-tube type with removable heads.
 3. Tubes shall be internally enhanced, seamless-copper type, and shall be rolled into tube sheets.
 4. Shall be equipped with victaulic fluid connections (2 pass) or flanged fluid connections (1, 2 or 3 pass).
 5. Shell shall be insulated with 3/4-in. (19-mm) closed-cell, polyvinyl chloride foam with a maximum K factor of 0.28. Heads may require field insulation.
 6. Shall have an evaporator drain and vent.
 7. Shall be equipped with factory-installed thermal dispersion chilled fluid flow switch.
- D. Condenser:
1. Shall be tested and stamped in accordance with ASME code (U.S.A.) for a refrigerant working-side pressure of 220 psig (1408 kPa).
 2. Shall be mechanically cleanable shell-and-tube type with removable heads.
 3. Tubes shall be internally enhanced, seamless-copper type, and shall be rolled into tube sheets.

4. Shall be equipped with victaulic water connections.
5. Unit sizes 325-400 shall have dual (2) independent refrigerant circuits.

E. Heat Machines:

1. Condenser shall be tested and stamped in accordance with ASME Code (U.S.A.) for a refrigerant working-side pressure of 300 psig (2068 kPa).
2. Heat machine condensers shall include factory-installed thermal insulation on the condenser, condenser flow switch and leaving water temperature sensor. Heat machine units require field-installed thermal insulation on the compressor discharge piping and waterbox heads because of high temperature.

F. Refrigeration Components:

Refrigerant circuit components shall include oil separator, high and low side pressure relief devices, discharge and liquid line shutoff valves, filter drier, moisture indicating sight glass, expansion valve, refrigerant economizer, and complete charge of compressor oil. The units shall have a complete operating charge of refrigerant HFC-134a.

G. Piping Requirements – Instrumentation and Safeties: Mechanical contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Scale range shall be such that design values shall be indicated at approximately mid-scale. Gages shall be installed in the entering and leaving water lines of the cooler and condenser.

H. Controls:

1. Unit controls shall include the following minimum components:
 - a. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
 - b. Separate terminal block for power and controls.
 - c. Separate 115-v power supply to serve all controllers, relays, and control components.
 - d. ON/OFF control switch.
 - e. Replaceable solid-state controllers.
 - f. Pressure sensors installed to measure suction, oil, economizer, and discharge pressure. Thermistors installed to measure evaporator entering and leaving fluid temperatures.
2. Unit controls shall include the following functions:
 - a. Automatic circuit lead/lag.

- b. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1° F (0.05° C).
- c. Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2° F to 2° F (0.1 to 1.1° C) per minute to prevent excessive demand spikes at start-up.
- d. Seven-day time schedule.
- e. Leaving chilled fluid temperature reset from return fluid.
- f. Chilled water and condenser water pump start/stop control.
- g. Chiller control for parallel chiller applications without addition of hardware modules and control panels (requires thermistors).
- h. Single step demand limit control activated by remote contact closure.
- i. The chiller control system shall have the ability to interface and communicate directly to the Trane control system. Chiller control panel shall reside on the "LonTalk FTT-10a network", and provide data using LonMark standard network variable types and configuration properties.
- j. The default standard display screen shall simultaneously indicate the following minimum information:
 - 1) date and time of day
 - 2) 24-character primary system status message
 - 3) 24-character secondary status message
 - 4) chiller operating hours
 - 5) entering chilled water temperature
 - 6) leaving chilled water temperature
 - 7) evaporator refrigerant temperature
 - 8) entering condenser water temperature
 - 9) leaving condenser water temperature
 - 10) condenser refrigerant temperature
 - 11) percent motor Rated Load Amps (RLA)
- k. In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:
 - 1) evaporator pressure
 - 2) condenser pressure
 - 3) bearing oil supply temperature
 - 4) compressor discharge temperature
 - 5) motor winding temperature
 - 6) number of compressor starts

- 7) control point settings
- 8) discrete output status of various devices
- 9) compressor motor starter status
- 10) spare input channels
- 11) line current and voltage for each phase
- 12) frequency, kW, kW-hr, demand kW
- 1. Schedule Function: The chiller controls shall be configurable for manual or automatic start-up and shutdown. In automatic operation mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting:
 - 1) A minimum of two 365-day occupancy schedules.
 - 2) Minimum of 8 separate occupied/unoccupied periods per day.
 - 3) Daylight savings start/end.
 - 4) 18 user-defined holidays.
 - 5) Means of configuring an occupancy timed override.
 - 6) Chiller start-up and shutdown via remote contact closure.
- m. Service Function: The controls shall provide a password protected service function which allows authorized individuals to view an alarm history file which shall contain the last 25 alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.
- n. Network Window Function: Each chiller control panel shall be capable of viewing multiple point values and statuses from other like controls connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The control panel shall also have access to the alarm history file of all like controllers connected on the network.
- o. Pump Control: Upon request to start the compressor, the control system shall start the chilled water pump, condenser water pumps and verify that flows have been established.
- p. The chiller control panel shall provide a relay output to initiate system changeover to free cooling (heat exchanger). This relay shall be energized upon initiation of free cooling at the chiller control panel.

- I. Safeties: Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
1. Loss of refrigerant charge.
 2. Reverse rotation.
 3. Low chilled fluid temperature.
 4. Motor overtemperature.
 5. High pressure.
 6. Electrical overload.
 7. Loss of phase.
 8. Loss of chilled water flow.
- J. Diagnostics:
1. The control panel shall include, as standard, a display:
 - a. Touch screen display consisting of ¼ VGA LCD (liquid crystal display) with adjustable contrast and backlighting.
 - b. Display shall allow a user to navigate through menus, select desired options and modify data.
 2. Features of the display shall include:
 - a. Display shall be customizable and allow up to 72 data points.
 - b. Display shall support both local equipment or network made for remote mount.
 - c. Display shall allow access to configuration, maintenance, service, set point, time schedules, alarm history and status data.
 - d. Display shall have one button for chiller on/ off.
 - e. Display shall include three levels of password protection against unauthorized access to configuration and maintenance information, and display set up parameters.
 - f. Display shall allow for easy connection of a portable hand held technician tool to access information and upload and/or download chiller settings.
 - g. Display shall be compatible with the existing central plant Trane control system and provide network alarm acknowledgement or indication and provide capability to fully monitor and control chiller.
 - h. Display alarms and parameters shall be capable of being displayed in full text.
 - i. Display shall be capable of displaying the last 50 alarms and will store a snapshot of a minimum of 20 status data parameters for each alarm.
 - j. Compressor run hours.

- k. Compressor number of starts.
- l. Compressor current.
- m. Time of day:
 - 1) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, and compressor before chiller is started.
 - 2) Diagnostics shall include the ability to review a list of the 30 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
 - 3) An alarm history buffer shall allow the user to store no less than 30 alarm events with clear language descriptions, time and date stamp event entry.
 - 4) The chiller controller shall include multiple connection ports for communicating with the local equipment network and the central plant control system.
 - 5) The control system shall allow software upgrade without the need for new hardware modules.
- K. Operating Characteristics:

Unit shall be capable of starting up with 95 F (35 C) entering fluid temperature to the evaporator.
- L. Electrical Requirements:
 - 1. Unit primary electrical power supply shall enter the unit at a single location.
 - 2. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
 - 3. Electrical contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.
 - 4. Electrical contractor shall wire the chilled water pumps and condenser water pumps to the chiller control circuit.
 - 5. Electrical contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system if applicable.
- M. Special Features:
 - 1. Wye-Delta Starter: Unit shall have a factory-installed, wye-delta starter to minimize electrical inrush current.

2. Vibration Isolation: Unit shall be supplied with rubber-in-shear vibration isolators for field installation.
3. Control Power Transformer: Unit shall be supplied with a factory-installed controls transformer that will supply 115-v control circuit power from the main unit power supply.
4. Temperature Reset Sensor: Unit shall reset leaving chilled fluid temperature based on outdoor ambient temperature or space temperature when this sensor is installed.
5. Minimum Load Control: Unit shall be equipped with factory-installed, microprocessor-controlled, minimum load control that shall permit unit operation down to 10% of full capacity.
6. One-Pass Evaporator: Factory-installed option shall reduce pressure drop for high flow applications.
7. Three-Pass Evaporator: Factory-installed option shall enhance performance for low flow applications.
8. Energy Management Module: A factory or field installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-point demand limit control (from 0 to 100%) activated by a remote contact closure.
9. LON Translator Control: Unit shall be supplied with factory or field-installed interface between the chiller and a Local Operating Network (LON, i.e., LonWorks FT-10A ANSI/EIA-709.1).
10. Navigator™ Hand Held Portable Display:
 - a. Portable hand held display module with a minimum of 4 lines and 20 characters per line.
 - b. Display menus shall provide clear language descriptions of all menu items, operating modes, configuration points and alarm diagnostics. Reference to factory codes shall not be accepted.
 - c. RJ-14 connection plug shall allow display module to be connected to factory-installed receptacle.
 - d. Industrial grade coiled extension cord shall allow the display module to be moved around the chiller.
 - e. Magnets shall hold the display module to any sheet metal panel to allow hands-free operation.
 - f. Display module shall have NEMA 4x housing.
 - g. Display shall have back light and contrast adjustment for easy viewing in bright sunlight or night conditions.
 - h. Raised surface buttons with positive tactile response.

11. Compressor Suction Service Valve: Optional refrigerant discharge isolation and liquid valves enable service personnel to store the refrigerant charge in the evaporator or condenser during servicing. This factory-installed option allows for further isolation of the compressor from the evaporator vessel.
12. Refrigerant Isolation Valves: Valves shall enable service personnel to store the refrigerant charge in the evaporator or condenser during servicing. During servicing, the in-chiller storage shall reduce refrigerant loss and eliminate time-consuming transfer procedures.
13. GFI Convenience Outlet: Shall be factory or field-installed and mounted with easily accessible 115-v female receptacle. Shall include 4 amp GFI receptacle.
14. Flanged Connections
15. Insulation Package: Package shall provide 3/4-in. thermal insulation on compressor suction housing, and suction line.
16. Non-Fused Disconnect: Provide a no load, lockable, through the door handle disconnect for unit power on the chiller.
17. 300 psig (2068 kPa) Evaporator Operating Pressure: Provide for water-side pressure operation up to 300 psig (2068 kPa).
18. 300 psig (2068 kPa) Condenser Operating Pressure: Provide for water-side pressure operation up to 300 psig (2068 kPa).

N. Start-up:

1. The chiller manufacturer shall provide a factory-trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-up, Operation and Maintenance manual provided by the chiller manufacturer.
2. Manufacturer shall supply the following literature:
 - a. Start-up, operation and maintenance instructions.
 - b. Installation instructions.
 - c. Field wiring diagrams.
 - d. One complete set of certified drawings.

2.2 FLUID COOLERS

- A. General: Air-cooled fluid coolers, arranged for vertical air flow. Suitable for roof-mounted installation.
- B. Unit Casing: Heavy-gauge, embossed aluminum for corrosion resistance. Multiple fan units shall be divided by full width baffles to separate individual fan sections, prevent air bypass and provide additional casing reinforcement.
- C. Provide assembled units with lifting eyes for rigging. Unit shall have 10 gauge galvanized steel legs.

- D. Fluid coil: Coils shall be constructed of 1/2-inch seamless copper tubing with copper fins. Headers shall be supplied with vents and drains. All coils shall be factory pressure tested to 400 PSI.
- E. Fans: All fans shall be aluminum propeller blade type with painted steel hubs. Fans shall be dynamically balanced and factory tested before shipping to ensure quiet operation. Fan diameters shall not exceed 30 inches.
- F. Fan Guards: Heavy-gauge, close meshed steel wire with vinyl coating for maximum rigidity and long life.
- G. Fan Motors: Fan motors shall be heavy duty PSC or three phase ODP type with permanently lubricated ball bearings and built-in overload protection. All motors shall be factory wired with leads terminating in a weathertight enclosure located opposite the header end of the unit. Leads on units shall terminate at a power block.

PART 3 - EXECUTION

3.1 EXAMINATION

Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might effect chiller performance, maintenance, and operation. Equipment locations shown on drawings are approximate. Determine exact locations before proceeding with installation.

3.2 EQUIPMENT INSTALLATION

- A. Install chiller on concrete base with isolation pads or vibration isolators.
 - 1. Concrete base is specified in Section 03 30 53.
 - 2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT
 - 3. Anchor chiller to concrete base according to manufacturer's written instructions.
 - 4. Charge the chiller with refrigerant, if not factory charged.
 - 5. Install accessories and any other equipment furnished loose by the manufacturer, remote control panel, and remote flow switches, according to the manufacturer written instructions and electrical requirements.
 - 6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.
 - 7. Chillers shall be installed so as to allow future chiller and pump installations as indicated on drawings.

- B. Install refrigerant piping as specified in ASHRAE Standard 15.
- D. Install thermometers and gages as recommended by the manufacturer and/or as shown on drawings.
- C. Piping Connections:
 - 1. Make piping connections to the chiller for chilled water, condenser water, and other connections as necessary for proper operation and maintenance of the equipment.
 - 2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
 - 3. Piping and equipment shall be arranged so that coils can be pulled from equipment in designated coil pull area indicated on plans. Where necessary, piping shall be provided valves and flanged connections in order to clear space for coil pulls.
 - 3. Extend vent piping from the relief valve and purge system to the outside.

3.3 STARTUP AND TESTING

- A. Engage manufacturer's factory-trained representative to perform startup and testing service.
- B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.
- C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the VA that the equipment operate and perform as intended.
 - 1. Check refrigerant charge is sufficient and chiller has been tested for refrigerant leak.
 - 2. Check bearing lubrication and oil levels.
 - 3. Verify proper motor rotation.
 - 4. Verify pumps associated with chillers are installed and operational.
 - 5. Verify thermometers and gages are installed.
 - 6. Verify purge system, if installed, is functional and relief piping is routed outdoor.
 - 7. Operate chiller for run-in-period in accordance with the manufacturer's instruction and observe its performance.
 - 8. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller.
 - 9. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
 - 10. Prepare a written report outlining the results of tests and inspections, and submit it to the VA.

- D. Engage manufacturer's certified factory trained representative to provide training for 4 hours for the VA maintenance and operational personnel to adjust, operate and maintain equipment, including self-contained breathing apparatus.

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